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Liquid Nitrogen Removal of Critical Aerospace Materials

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ABSTRACT

Identification of innovative solutions to unique materials problems is an every-day quest for members of the aerospace community. Finding a technique that will minimize costs, maximize throughput, and generate quality results is always the target. United Space Alliance Materials Engineers recently conducted such a search in their drive to return the Space Shuttle fleet to operational status.

The removal of high performance thermal coatings from solid rocket motors represents a formidable task during post flight disassembly on reusable expended hardware. The removal of these coatings from unfired motors increases the complexity and safety requirements while reducing the available facilities and approved processes. A temporary solution to this problem was identified, tested and approved during the Solid Rocket Booster (SRB) return to flight activities.

Utilization of ultra high-pressure liquid nitrogen (LN2) to strip the protective coating from assembled space shuttle hardware marked the first such use of the technology in the aerospace industry. This process provides a configurable stream of liquid nitrogen (LN2) at pressures of up to 55,000 psig.

The performance of a one-time certification for the removal of thermal ablatives from SRB hardware involved extensive testing to ensure adequate material removal without causing undesirable damage to the residual materials or aluminum substrates.

Testing to establish appropriate process parameters such as flow, temperature and pressures of the liquid nitrogen stream provided an initial benchmark for process testing. Equipped with these initial parameters engineers were then able to establish more detailed test criteria that set the process limits.

Quantifying the potential for aluminum hardware damage represented the greatest hurdle for satisfying engineers as to the safety of this process. Extensive testing for aluminum erosion, surface profiling, and substrate weight loss was performed.

This successful project clearly demonstrated that the liquid nitrogen jet possesses unique strengths that align remarkably well with the unusual challenges that space hardware and missile manufacturers face on a regular basis. Performance of this task within the confines of a critical manufacturing facility marks a milestone in advanced processing.